International Journal of Industrial Engineering &
Technology (IJIET)
ISSN(P): 2277-4769; ISSN(E): 2278-9456
Vol. 5, Issue 1, Feb 2015, 19-32

ENHANCING TERTIARY EDUCATION THROUGH THE INFUSION OF TECHNOLOGIES: EXPLORING THE CHALLENGES

BENJAMIN T. K. BOISON[1] & CLEMENT K. DZIDONU[2]

[1]Lecturer, Koforidua Polytechnic, Koforidua Ghana

[2]President, Accra Institute of Technology, Accra, Ghana

ABSTRACT

In this paper, challenges to the deployment of technologies in higher institutions of learning are screened for using Principal Component Analysis. This investigation is made in a quantitative research context. Data is accessed from 100 students and 50 each of faculty members and school administrators in public universities in Ghana which are technologically advanced. Challenges are measured on a five-point likert scale using a self-administered questionnaire. All identifiable challenges significantly hinder the deployment of technologies in higher institutions of learning in Ghana. Lack of technology training for students, faculty members and university administrators is among the most influential challenges found, with an extraction value of .975 contributed by it. Identified challenges are placed in three components. The first component relates to training challenges and contributes to the higher variation of 49.7%. The second component of challenges relates to infrastructure, and this contributes 26% of the variation. The third component relates to accessibility, which accounts for 15.4% of the variation. Therefore, higher academic institutions would have to prioritise training and infrastructural challenges in a situation of scarce resources.

KEYWORDS: Technology, Higher Education Institutions, Technology Infusion, Challenges, Principal Component Analysis

INTRODUCTION

Human beings have found their way towards the deployment and leveraging of technologies in learning and teaching, resulting in a remarkable change in the quality and impact of education in most jurisdictions in recent times (Ezziane, 2007; Hussain & Safdar, 2008). Additionally, the education section sector is gradually catching up with industry in terms of the use of technologies in facilitating the accomplishment of activities and minimising the cost of hiring labour. Moreover, there is the general belief that the dynamic capabilities of technologies make them deployable in teaching and learning now and in future (Ezziane, 2007). This belief is rooted in the rapid advancement in the functions of educational technologies and the evolvement of robust technologies that address specific issues in teaching and learning (Capper, 2003; Rhema &Miliszewska, 2010). Hence, institutions failing to incorporate technologies in learning and teaching are missing out on technological innovations that play a pivotal role in institutional management and societal building. This argument would better be understood when the role and advantage of technologies in teaching and learning are acknowledged.

It is admitted in practice and research that technologies have the basic role of maximising the efficiency of human skills and competencies (Obuobi, Richards & Watts, 2006; Bhasin, 2012). In terms of education, technology infusion is aimed at facilitating teaching, learning and the accomplishment of administrative activities (Obuobi*et al*, 2006; Aguele, 2012; Bhasin, 2012). This means that technologies are deployed in an academic institution at three levels: teaching,

learning and accomplishment of administrative processes. According to Keong, Horani& Daniel (2005: 49), the advantage of technological infusion in an academic institution is a reduction in costs and the accomplishment of tasks with much flexibility, speed, convenience and ease, regardless of what level of education is involved. Yet, the extent to which an institution savours a technology in this respect depends on the institution's dynamic capabilities in using it (Keong*et al*, 2005; Bhasin, 2012), where dynamic capabilities in this context would depend on knowledge and experience with the specific technologies and their uses.

Keong*et al.* (2005) posits that many categories of technologies are deployable in an academic environment. They however add that the bulk of technologies are information systems used basically for disseminating information across stakeholders (i.e. university council, management, faculty, students, parents and potential students) in an academic institution. Many studies (e.g. Agyei&Voogt, 2010; Ezziane, 2007; Dağlı&Öznacar, 2013, etc.) have identified the computer and its applications, internet, intranet, mobile phones and other e-learning systems as information systems centred on information dissemination across institutional stakeholders. But along the disclosure of these and various types of technologies in these studies, the challenges under which they are adopted in academic settings are strongly acknowledged. It is admitted that identifiable challenges are still the main deadlock to the maximum relishing of technologies in teaching and learning (Capper, 2003; Obuobi*et al*, 2007; Amenyedzi, Lartey&Dzomeku, 2011), especially in developing African countries (Obuobi*et al*, 2007; Amenyedzi, Lartey&Dzomeku, 2011).

Today, many challenges are reported to confront academic institutions in deploying technologies in teaching and learning. A personal survey of related studies indicate that the prevalence of these challenges permeate all educational sectors (i.e. basic, secondary and tertiary). Yet, some industry experts have expressed the concern that the infusion of technologies in teaching and learning, especially in developing African countries, at the basic and secondary school level is not rigorous and sometimes informal (Adjei, 2010; Aguele, 2012). As a result, it is inappropriate to consider basic and second cycle instructions when conducting studies on the challenges of deploying technologies in teaching and learning. In view of these, possibly, most studies (e.g. Sell, 1997; Sife, Lwoga&Sanga, 2007; Oye, Salleh&Iahad, 2011; Mbodila, Jones &Muhandji, 2013)have been focused on revealing the challenges of deploying technologies in teaching and learning at the tertiary educational level. However, there are colossal gaps in the academic literature of the subject.

A personal survey of studies on the subject indicates that the challenges confronting the infusion of technologies in teaching and learning are placed into infrastructure, accessibility and training spheres. Though there is considerable harmony in studies that have identified these challenges, there is a school of thought that their disclosure has been based on mere mean scores and frequencies by researchers (e.g. Sife, Lwoga&Sanga, 2007; Oye, Salleh&Iahad, 2011; etc.). This means that a robust statistical procedure such as the use of Principal Component Analysis or Principal Component Analysis in screening for the challenges and categorising them in order of effect is not used to reach these challenges. As a result, there is little evidence on how to prioritise these challenges based on their degrees of effect on the infusion of technologies in teaching and learning. This prioritisation is important because institutions would often adopt technologies in the face of scarce resources. As far as the current body of evidence on the subject is concerned, prioritisation cannot be carried out because mean scores or frequencies on which the prevalence of these challenges are currently based do not give sufficient scrutiny to variables in the screening process. In essence, variables which serve as weak or insignificant challenges would be classified among the strong ones when mean scores and frequencies are used. This is practically misleading.

Having considered this gap in the academic literature of the subject, this study is conducted to screen for challenges that confront higher institutions in infusing technologies in teaching and learning. This study contributes something peculiar to the current body of studies, which has to do with the categorisation of the challenges and their ordering in a hierarchy that visualises how much each of them affects infusion of technologies into teaching and learning. The objective on which this study is based is stated as follows.

OBJECTIVE OF THE STUDY

The objective of this study is to screen for challenges that hinder the infusion of technologies into teaching and learning in higher institutions in Ghana. The study adopts the Principal Component Analysis (PCA) in classifying these challenges and ordering them in a hierarchy that communicates the relative effect of each challenge on the deployment of technologies in teaching and learning. The relevance of this study is stated as follows.

RELEVANCE OF THE STUDY

The importance of this study is seen in its contribution to academic debate on challenges that hinder the infusion of technologies in teaching and learning in higher institutions of learning. The study therefore expands the current academic literature of the subject, as well as the public's knowledge on it. Practically, the study would enable higher institutions to prioritise the remedy of these challenges in the face of scarce resources.

LITERATURE REVIEW

Undoubtedly, technologies are very relevant to teaching and learning in higher institutions of learning. Technologies are also needed in accomplishing administrative activities in tertiary institutions. These assertions are made in view of the several research studies (e.g. Rhema & Miliszewska, 2010; Sarfo-Gyimah, 2010; Owoche, 2014; etc.) which have shown that the deployment of technologies in higher institutions of learning enhances the quality of teaching and learning. It is also made evident that the deployment of technologies yields efficiency in the accomplishment of administrative activities (Ezzaine, 2007; Owoche, 2013). Also, the infusion of technologies in higher institutions of learning helps university management to optimise the cost of running the universities (Rhema & Miliszewska, 2010; Owoche, 2013). It is even more impressive to note that the use of technologies in higher institutions of learning could impact profitability or result in a business case (Sarfo-Gyimah, 2010; Owoche, 2013). Nonetheless, the oddity associated with the infusion of technology into teaching and learning is the fact that several challenges hinder the process (Capper, 2003; Obuobi*et al,* 2007; Amenyedzi, Lartey & Dzomeku, 2011).

Several challenges hinder the deployment of educational technologies. Though all challenges faced in the deployment of technologies in tertiary institutions are driven by financial drawback (Sell, 1997; Sife*et al,* 2007), it is important to understand them individually. These challenges are generally placed into three groups or components.

The first component has to do with challenges relating to infrastructure (Obuobi*et al,* 2007; Amenyedzi, Lartey & Dzomeku, 2011). These challenges include lack of suitable technologies, lack of appropriate technology support systems (e.g. electricity, external service partners, etc.), lack of internal technical teams and expertise and lack of an appropriate user environment. The second batch of challenges relate to accessibility (Sell, 1997; Sife*et al,* 2007; Oye et *al,* 2011). This category includes inability of individuals or the academic institution to afford technologies, inability of students and faculty to use them and lack of motivation for using technologies. The third category of challenges relate to training (Sell, 1997;

Sifeet al, 2007; Oyeet al, 2011; Sell, 1997; Sifeet al, 2007). This category includes lack of training for students and faculty on the use of technologies. Another element of this category is lack of effective training for students and faculty. Based on a personal survey of studies, the challenges of infusing technologies in teaching and learning (including administrative uses) in higher institutions are conceptualised in Figure 1. Though other related challenges exist (Sifeet al, 2007), these are the dominant and major ones identified in related studies of this research. Moreover, studies conducted in many different geographical settings yielded these challenges. We would therefore consider them as standard challenges and therefore benchmark the investigation on them.

According to Sell *et al.* (1997), the productivity of technologies can be maximised by remedying these challenges at the various stages of infusing technologies in teaching and learning. Considering their argument, it is therefore important to understand the relative weight of the effect of each of the challenges at each stage of technology deployment in an academic institution. The problem is that these challenges have been identified using statistical procedures that do not make way for identifying their relative weight of effect on technology infusion. Yet, there is much to the gap identified in the academic literature of this study.

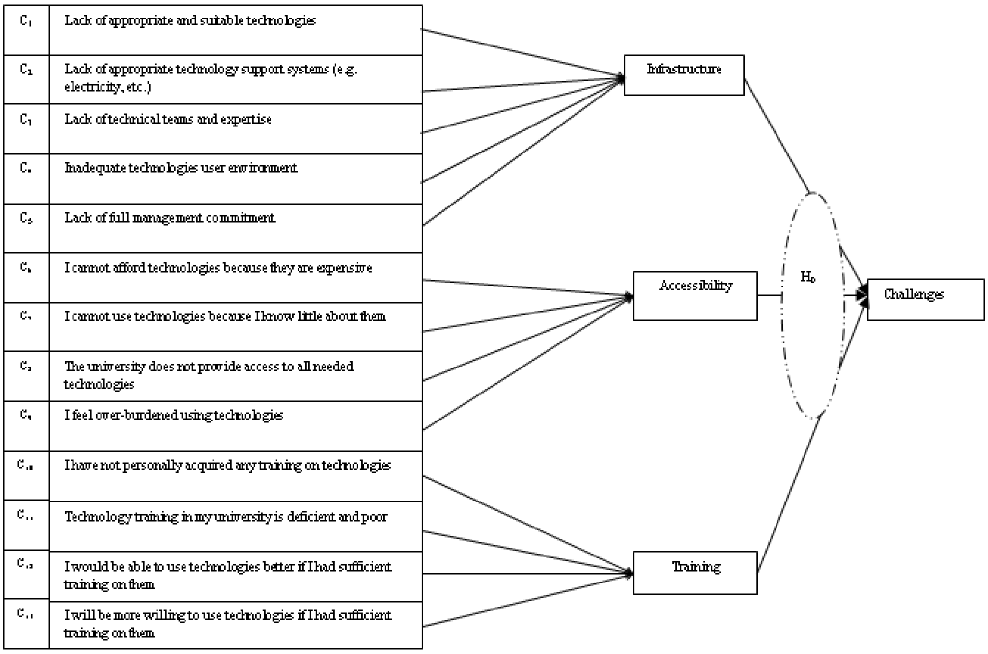

Figure 1: Conceptual Model of the Study

Adjusted from: Sell (1997)

Generally, academic debate on challenges confronting tertiary institutions in the ownership and use of technologies is weak. This is because the number of studies conducted on the subject is insufficient. Though challenges in Figure 1 are identified in various studies (e.g. Herselman& Hay, 2003; Mac-Ikemenjima, 2005; Mbodila*et al*, 2013; Oye*et al*, 2011; Sell, 1997; Sife*et al*, 2007), it is observed that researchers have given little attention to this area of study. From a Ghanaian point of view, this situation is worse because studies focused on challenges confronting institutions of higher learning in the deployment of technologies are very scarce. The lack of studies on the subject is a problem because it weakens existing evidences on how to maximise the effectiveness and efficiency of technologies and their deployment.

With regard to these gaps in the subject's literature, there are several implications for future research. First of all, there is the need to boost research work on the subject from a global perspective. Secondly there is the need to use more robust research and statistical procedures to screen for these challenges, enabling their classification in a hierarchy that identifies which of them makes the weightiest effect on technology deployment in tertiary institutions and which makes the least effect. There is also the need to conduct related studies in geographical areas where they are scarce. This means that more related studies are needed in a Ghanaian context, since very few related studies have been conducted from a Ghanaian point of view. This study is an avenue for addressing to these implications and the identified gaps in the literature. We intend to screen for the challenges hindering the infusion of technologies in higher institutions of learning in Ghana by using robust statistical and research procedures. The conceptual model of Figure 1 is used as a basis of testing the following hypothesis, where H_0 and H_1 are the null and alternative hypothesis respectively.

HYPOTHESES

H_0: All identifiable challenges significantly hinder the infusion of technologies in teaching and learning in higher institutions of study in Ghana.

H_1: Not all identifiable challenges significantly hinder the infusion of technologies in teaching and learning in higher institutions of study in Ghana.

METHODS AND MATERIALS

In this research, a quantitative research approach was employed. We used this approach on the basis of the need to generalise findings over all tertiary institutions in Ghana through the adoption of a randomised sampling procedure. In fact, the use of Principal Component Analysis and its statistical assumptions takes place in a quantitative research context. The population of the study was students, faculty members and university administrators in public universities in Ghana. Nevertheless, these institutions were however selected on the basis of their technological advancement. Their level of technological development is the transformative phase according to the continuum of approaches for ICT development in schools. The study's target population was students, faculty members and administrators who had been in the chosen tertiary institutions for at least two years. Respondents were required to have been in the chosen university for at least 2 years to ensure that they provided information based on substantial practical experience with the university's technology deployment endeavour. Since we did not have access to data on all students from the tertiary institutions, we chose a convenient sample of 100 undergraduate third and fourth year students. Third and fourth year students were used because they must have spent at least 2 years in their respective universities. A sample size of 50 each of administrators and faculty members was chosen. Moreover, these sample size was also chosen by convenience. The sample size of faculty members and administrators was chosen based on evidences about which of them could be contacted within a specified period.

A self-administered questionnaire was the main instrument used in data collection. A self-administered questionnaire was used because it had features that allowed participants to respond at their convenient time or in the absence of the researchers. The challenges of infusing technologies into teaching and learning, as conceptualised in Figure 1, were measured on a five-point likert scale [Strongly disagree (1); disagree (2); not sure (0); agree (4) and strongly agree (5)]. Questionnaires were administered by hand delivery to students and a few faulty members and school administrators, while electronic questionnaires were administered to most of the faculty members and administrators. An accidental approach was used in contacting students, since no information on them was accessible prior to data collection. Therefore,

their response was instant, unlike faculty members and administrators who were allowed five working days to complete questionnaires. The researchers asked the students to indicate their levels before administering questionnaires to them. This was done to ensure that only third and fourth year students responded.

Before questionnaires were administered, formal notices were written to the authorities of the participating universities. To ensure that it was reliable and valid, the design of the questionnaire was based on standard measures. It was also submitted to many research experts for scrutiny and suggestions, ensuring that errors were duly corrected. Moreover, the instrument's reliability coefficient was .923, which reflects a high reliability of the study's data. The Statistical Package for the Social Sciences (SPSS), Version 21, with its nested AMOS software is used in data analysis. The hypothesis is tested using Principal Component Analysis (PCA). This tool is used as a result of its robustness and its specialised function of classifying variables. It also provides statistical estimates (called extraction values) that can be used to create a hierarchy of the variables in terms of the strength of their influence. In the next section are the results of this study.

RESULTS

This section of the study unfolds findings in line with the hypothesis stated. For the sake of clarity, it is important to restate the null hypothesis: all identifiable challenges significantly hinder the infusion of technologies in teaching and learning in higher institutions of study in Ghana. We would test it at 5% significance level using Principal Component Analysis (PCA). Table 1 shows the descriptive statistics of all identifiable challenges.

Table 1: Descriptive Statistics

Variable	Observations	Minimum	Maximum	Mean	Std. Deviation
C1	200	2.000	3.000	2.200	0.402
C2	200	2.000	4.000	3.200	0.541
C3	200	1.000	2.000	1.300	0.461
C4	200	2.000	4.000	3.200	0.541
C5	200	3.000	5.000	4.200	0.541
C6	200	4.000	5.000	4.200	0.402
C7	200	2.000	3.000	2.300	0.461
C8	200	4.000	5.000	4.300	0.461
C9	200	0.000	2.000	0.900	0.541
C10	200	4.000	5.000	4.500	0.561
C11	200	3.000	5.000	3.600	0.667
C12	200	4.000	5.000	4.500	0.503
C13	200	4.000	5.000	4.600	0.492

Table 1 shows the descriptive statistics of all identifiable challenges to the deployment of technologies in Ghanaian tertiary institutions. The higher the mean score associated with a variable or challenge, the more it exists as a challenge that inhibits the infusion of technologies in higher institutions of learning. From the table, C13 has the highest mean score (M = 4.60, SD = .49), followed by C12 (M = 4.50, SD = .50) and C10 (M = 4.50, SD = .56). Variables such as C3 (M = 1.30, SD = .46) and C9 (M = .90, SD = .54) relatively pose themselves as very weak challenges in the academic environment. Though these mean scores are relevant to getting a clue about the relative strength of each challenge, the correlation matrix of the variables are worth considering. This is because PCA works on the principle of high correlations among variables, resulting in the categorisation of variables based on these correlations. Table 2 therefore shows this matrix.

Table 2: Correlation Matrix

Variables	C1	C2	C3	C4	C5	C6	C7	C8	C9	C10	C11	C12	C13
C1	**1**	**0.836**	**0.764**	**0.836**	**0.836**	**0.375**	**0.218**	**0.218**	**0.557**	**0.500**	**0.678**	**0.500**	**0.408**
C2	**0.836**	**1**	**0.689**	**1.000**	**0.655**	-0.093	-0.122	-0.122	**0.379**	0.186	**0.392**	0.186	0.152
C3	**0.764**	**0.689**	**1**	**0.689**	**0.689**	**0.218**	**0.524**	**0.524**	0.122	**0.655**	**0.724**	**0.655**	**0.535**
C4	**0.836**	**1.000**	**0.689**	**1**	**0.655**	-0.093	-0.122	-0.122	**0.379**	0.186	**0.392**	0.186	0.152
C5	**0.836**	**0.655**	**0.689**	**0.655**	**1**	**0.371**	**0.284**	**0.284**	**0.724**	0.186	**0.392**	0.186	0.152
C6	**0.375**	-0.093	**0.218**	-0.093	**0.371**	**1**	**0.764**	**0.764**	**0.557**	**0.500**	**0.302**	**0.500**	**0.408**
C7	**0.218**	-0.122	**0.524**	-0.122	**0.284**	**0.764**	**1**	**1.000**	0.122	**0.655**	**0.395**	**0.655**	**0.535**
C8	**0.218**	-0.122	**0.524**	-0.122	**0.284**	**0.764**	**1.000**	**1**	0.122	**0.655**	**0.395**	**0.655**	**0.535**
C9	**0.557**	**0.379**	0.122	**0.379**	**0.724**	**0.557**	0.122	0.122	**1**	-0.186	-0.112	-0.186	-0.152
C10	**0.500**	0.186	**0.655**	0.186	0.186	**0.500**	**0.655**	**0.655**	-0.186	**1**	**0.905**	**1.000**	**0.816**
C11	**0.678**	**0.392**	**0.724**	**0.392**	**0.392**	**0.302**	**0.395**	**0.395**	-0.112	**0.905**	**1**	**0.905**	**0.739**
C12	**0.500**	0.186	**0.655**	0.186	0.186	**0.500**	**0.655**	**0.655**	-0.186	**1.000**	**0.905**	**1**	**0.816**
C13	**0.408**	0.152	**0.535**	0.152	0.152	**0.408**	**0.535**	**0.535**	-0.152	**0.816**	**0.739**	**0.816**	**1**

Table 2 shows the correlation matrix of all potential challenges that hinder the deployment of technologies in academic institutions of higher learning. As seen from the table, a higher number of the correlations in the matrix (i.e. those in bold cases) are significant at 5% significance level. This is generally one indicator for a strong and valid PCA. Also, the stronger the correlation between two variables, the higher the tendency that the pair forms part of the significant challenges that hinder the deployment of technologies in a tertiary institution. Yet, the validity of the PCA is still verified using two other statistics. Table 3 shows the values of these statistics.

Table 3: KMO and Bartlett Test of Sphericity

KMO	.932
Bartlett Chi-square (Critical value)	99.617
df	156
Sig.	.000

Table 3 shows the Bartlett's test of sphericity and KMO test. These two tests are used to verify the validity of the PCA. Generally, the KMO value must be 0.700 or more for a valid and strong PCA. Also, the Bartlett's test of sphericity must be significant at 5% level. From the table, both criteria are satisfied. Hence, the PCA is valid. This implies that results relating to the PCA would be valid. Figure 1 shows the number of components extracted in the PCA. But before results in this table are discussed, it is worth saying that all variables are retained as significant challenges hindering the infusion of technologies in teaching and learning. This information is sourced from Figure 3, which contains the extraction values of each variable. These values are equivalent to R^2 in linear regression analysis. Moreover, for a variable to be retained it extraction value must be 0.500 or more. Evidently, this condition is satisfied for all variables (see Figure 3). If any variable had an extraction value less than this value, it would have been removed out of the list of identifiable challenges conceptualised in Figure 1. The higher an extraction value, the stronger the variation being contributed by a variable that represents a challenge. The scree plot in Figure 2 gives an idea about the number of components extracted.

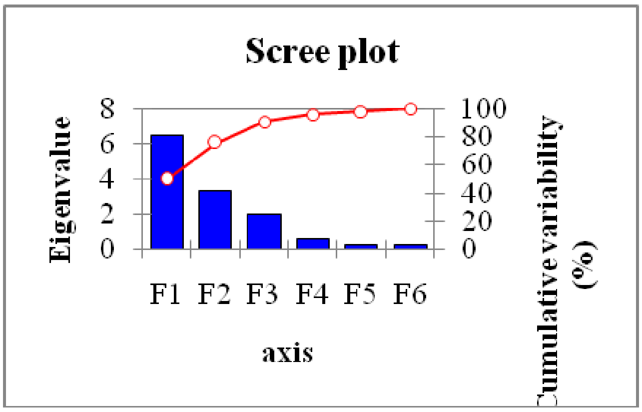

Figure 2: Scree Plot

Figure 2 shows the number of components extracted out of all variables or challenges. Apparently, three components are formed. This is because the bulk of the Eigen values are represented by these components. Moreover, the remaining three factors are almost flat, or have very small Eigen values individually. Yet, what is still not known at this stage is the strength of the effect of each component. It is worth noting that while extraction values reflect the relative variation contributed by each variable (challenge), the variation within a cluster of variables or a component is represented by the variability. Table 4 offers information about this.

Table 4: Variability (Eigen Value) Accounted

	F1	F2	F3	F4	F5	F6
Eigenvalue	6.459	3.375	1.995	0.626	0.295	0.250
Variability (%)	49.686	25.960	15.350	4.815	2.267	1.922
Cumulative %	49.686	75.646	90.996	95.811	98.078	200.000

Table 4 shows the Eigen values of factors retrieved. An Eigen value is proportional to the variation contributed by a factor. In this respect the higher the value of this variation, the greater the strength of a factor relative to other factors. In the table, the first factor contributes 49.7% of the variation; the second factor accounts for 26% of the variation and the third factor accounts for 15.4% of the variation. These three factors account for 91% of the variation. The higher the variation accounted by a factor, the more serious we could reckon its constituent challenges to hinder the deployment of technologies at the tertiary level. There is therefore the need to know challenges that make up each factor or component. Table 5 shows this information.

Table 5: Components Extracted

	F1	F2	F3	F4	F5	F6
C1	0.323	**0.293**	0.025	-0.227	-0.092	-0.050
C2	0.208	**0.433**	-0.142	0.099	0.292	-0.261
C3	0.345	**0.120**	-0.114	0.491	-0.063	0.110
C4	0.208	**0.433**	-0.142	0.099	0.292	-0.261
C5	0.254	**0.307**	0.268	0.119	-0.388	0.513
C6	0.233	-0.187	**0.468**	-0.356	0.078	-0.249
C7	0.266	-0.299	**0.272**	0.379	0.086	-0.063
C8	0.266	-0.299	**0.272**	0.379	0.086	-0.063
C9	0.101	0.282	**0.552**	-0.296	0.084	0.010
C10	**0.335**	-0.218	-0.201	-0.148	-0.101	-0.251
C11	**0.333**	-0.050	-0.288	-0.251	-0.471	0.113
C12	**0.335**	-0.218	-0.201	-0.148	-0.101	-0.251
C13	**0.289**	-0.198	-0.197	-0.258	0.629	0.613

Table 5 shows items of the three factors retained. It generally shows a relationship between factors retrieved and variables. The cluster of variables in bold cases form the constituent elements of the factors retrieved. The first factor is made up of C10, C11, C12 and C13. The second factor is made up of C1, C2, C3, C4 and C5, and the third factor is made up of C7, C8, C9 and C10. The challenges represented by each of these variables can be seen in Figure 3.

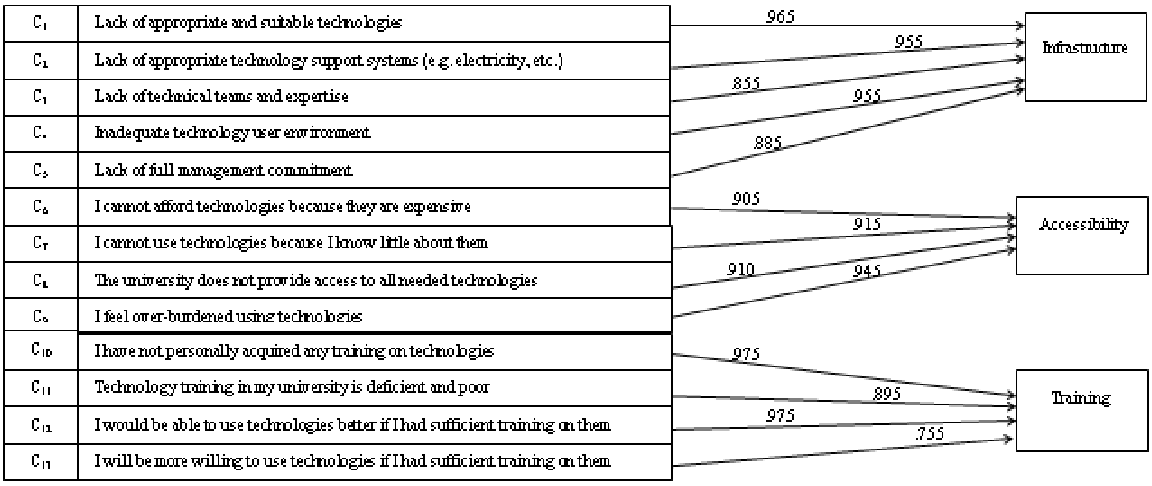

Figure 3: Resulting Conceptual Model

Figure 3 shows the resulting conceptual model of the challenges hindering the deployment of technologies in tertiary institutions in Ghana. The components retrieved can best be described as challenges relating to infrastructure, accessibility and training. With respect to Table 4, the highest variability is contributed by training (49.7%). This means that challenges relating to training pose more serious challenges in the infusion of technologies in higher institutions in Ghana. This is followed by accessibility (26%), and infrastructure (15.4%). The values on each arrow leading to a factor from a variable represent the extraction value of the variable. By principle, the higher the size of this value, the higher the influence of the corresponding variable as a challenge. So far, we have shown the variations contributed by each variable or challenge using the extraction values and the variation contributed by them when placed in components using variability (%). What is yet to be seen is an arrangement of all challenges in decreasing order of extraction value. This is shown in Table 6.

Table 6: Ranked Communalities

Variable	Extraction	Ranking
C10	0.975	12.5
C12	0.975	12.5
C1	0.965	11
C2	0.955	9.5
C4	0.955	9.5
C9	0.945	8
C7	0.915	7
C8	0.910	6
C6	0.905	5
C11	0.895	4
C5	0.885	3
C13	0.855	2
C13	0.755	1

Table 6 shows the ranked communalities of the variables. The ranked values indicate the weight of the effect contributed by each variable. The higher this value, the higher the seriousness of the effect made by the corresponding variable or challenge. Variables with the same values of ranking have equal extraction values (e.g. C10 and C12). From the table, C10 and C12 are the most influential challenges, followed by C1. The bearer of the smallest influence or variation is C13. It can be seen that even C13 has an extraction value quite larger than 0.50. This shows that all the variables generally

represent dominant challenges hindering the deployment of technologies in higher institutions of learning. Figure 4, Figure 5 and other tables in the Appendix reflect the validity of the PCA and its other important indicators.

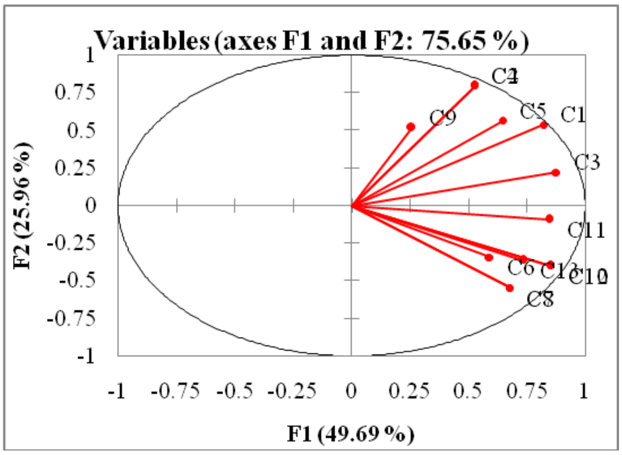

Figure4: Correlation Circle 1

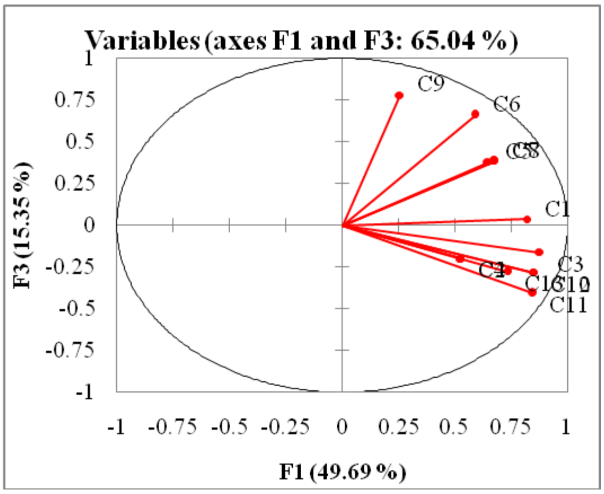

Figure 5: Correlation Circle 2

Figures 4 and 5 constitute the correlation circles of the PCA. These figures graphically reflect the majority of correlations in Table 2. The closer the red lines of two variables to each other, the higher their correlations. It is also expected that variables fall far off from the centre where the red lines originate. But in a situation where a variable gets closer to the centre, it is very likely that it is related to variables that form part of other factors or components. The figure also confirms that all the correlations are positive. This is because there are no variables at the opposite side of the centre. A positive correlation in this context means that the influence of one challenge increases as the effect of another challenge increases. Based on this result, we would retain the hypothesis that all identifiable challenges significantly hinder the deployment of technologies in higher institutions of learning in Ghana. Results are discussed in the next section.

DISCUSSIONS

Findings indicate that all identifiable challenges hinder the deployment of technologies in higher institutions of learning in Ghana. Before this study was conducted, it was feared that not all these challenges hinder the deployment of technologies in view of the weakness of the statistical tool and procedure used to identify them in previous studies (e.g. Herselman & Hay, 2003; Mac-Ikemenjima, 2005; Mbodila*et al*, 2013; Oye*et al*, 2011; Sell, 1997; Sife*et al*, 2007). While it

may seem that the realisation of these variables as significant challenges hindering the use and ownership of technologies in previous studies was by chance, this study confirms them as realistic findings or phenomena. This is because this study's findings are justifiably more robust and credible, redeeming previous results from their weaknesses. There is however the need for more related studies to be conducted to confirm a consistent pattern. This direction is much needed because there are no identifiable studies (which employed similarly robust tool and procedure) to which these results may be compared.

The study also reveals that training-related challenges make the largest of influence on the deployment of technologies in higher institutions in Ghana. This result is confirmatory to many other studies conducted in Ghana (e.g. Obuobi*et al*, 2006; Sarfo & Ansong-Gyimah, 2010). But the situation is different for few studies conducted in more developed countries (e.g. Sell, 1997; Sife*et al*, 2007). It is agreeable that in developed countries, training problems would be minimal because the general ability of people to use technologies is higher relative to developing African countries (Sell, 1997). Moreover, the fact that training problems make the highest influence in a Ghanaian context is logical and practicable. This is because all the participating universities had some level of access to technologies and their infrastructure; hence the concern of students, faculty members and administrators would be geared towards their ability to use available technologies, regardless of how insufficient they are. Of course, technology infrastructure may be poor in Ghana, but stakeholders would still have the edge to use them in this state. They are therefore more likely to identify training as a serious gap relative to infrastructure and accessibility. This study provides a clue about which individual challenge poses the highest effects and which poses the least effects. This area of contribution is unique, as previous studies did not delve into it (e.g. Herselman& Hay, 2003; Mac-Ikemenjima, 2005; Mbodila*et al*, 2013; Oye*et al*, 2011; Sell, 1997; Sife*et al*, 2007). Lack of training for students, faculty members and university administrators, coupled with the insufficiency of training on the use of technologies, is the most influential challenge found.Unwillingness to use technologies makes the least influence on the deployment of technologies in higher institutions of learning, but it is still a significant challenge in Ghana. According to Oye*et al*, (2006), this situation is characteristic of Africans and would take some time to remedy. The advantage tertiary institutions stand is that one challenge is highly correlated to other challenges, implying that a remedy of the basic ones automatically nullifies others. The most basic one could be lack of infrastructure and the skill of using technologies. Therefore, its remedy would yield the remedy of others.

CONCLUSIONS

Allidentifiable challenges significantly hinder the deployment of technologies in higher institutions of learning in Ghana. Lack of training for students, faculty members and university administrators is one of the most influential challenges found. This challenge is coupled with the insufficiency of training on the use of technologies. This means that even training programs that could be accessed by individuals are insufficient or possibly ineffective. Unwillingness to use technologies makes the least influence on the deployment of technologies in higher institutions of learning.

The PCA places identified challenges in three components. The first component relates to training challenges and contributes the higher variation of 49.7%. The second component of challenges relates to infrastructure, and this contributes 26% of the variation. The third and final component relates to accessibility. This accounts for 15.4% of the variation. This means that higher academic institutions would have to prioritise training and infrastructural challenges in a situation of scarce resources. Making sufficient access to training on the use of technologies and maximising the adequacy of this training to students, faculty members and administrators is the foremost step to remedying the challenges confronting academic institutions in owing and using technologies.

RECOMMENDATION AND FUTURE RESEARCH DIRECTIONS

It is recommended that higher institutions in Ghana provide adequate infrastructure for the utilisation of technologies in teaching and learning. This means that a congenial and well-equipped environment is needed to set the foundation for effective deployment of technologies. Since some technology infrastructure already exists in some universities, managements should endeavour to train their students and staff to use them effectively. Considering the fact that all challenges found in this study are basically driven by the availability of financial resource, university managements need to enhance their commitment to the infusion of technologies. By so doing, efforts would be made by them towards providing adequate financial resources for technology incorporation in teaching and learning. Future researchers are encouraged to conduct this study from the perspective of private universities, or as a comparative study of private and public universities. This would enhance existing contributions to academic debates on the subject.

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APPENDICES

Table 7: Factor Loadings

	F1	F2	F3	F4	F5	F6
C1	0.820	0.539	0.035	-0.179	-0.050	-0.025
C2	0.527	0.796	-0.200	0.079	0.158	-0.131
C3	0.877	0.221	-0.162	0.389	-0.034	0.055
C4	0.527	0.796	-0.200	0.079	0.158	-0.131
C5	0.647	0.565	0.379	0.094	-0.211	0.257
C6	0.591	-0.343	0.661	-0.281	0.043	-0.125
C7	0.677	-0.549	0.384	0.300	0.047	-0.032
C8	0.677	-0.549	0.384	0.300	0.047	-0.032
C9	0.257	0.518	0.780	-0.234	0.046	0.005
C10	0.852	-0.401	-0.284	-0.117	-0.055	-0.125
C11	0.847	-0.092	-0.407	-0.198	-0.256	0.056
C12	0.852	-0.401	-0.284	-0.117	-0.055	-0.125
C13	0.734	-0.363	-0.278	-0.204	0.342	0.307

Table 8: Correlation between Factors and Variables

	F1	F2	F3	F4	F5	F6
C1	0.820	0.539	0.035	-0.179	-0.050	-0.025
C2	0.527	0.796	-0.200	0.079	0.158	-0.131
C3	0.877	0.221	-0.162	0.389	-0.034	0.055
C4	0.527	0.796	-0.200	0.079	0.158	-0.131
C5	0.647	0.565	0.379	0.094	-0.211	0.257
C6	0.591	-0.343	0.661	-0.281	0.043	-0.125
C7	0.677	-0.549	0.384	0.300	0.047	-0.032
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C9	0.257	0.518	0.780	-0.234	0.046	0.005
C10	0.852	-0.401	-0.284	-0.117	-0.055	-0.125
C11	0.847	-0.092	-0.407	-0.198	-0.256	0.056
C12	0.852	-0.401	-0.284	-0.117	-0.055	-0.125
C13	0.734	-0.363	-0.278	-0.204	0.342	0.307

Table 9: Contributions of the Variables (% Variability)

	F1	F2	F3	F4	F5	F6
C1	10.422	8.601	0.063	5.140	0.845	0.252
C2	4.306	18.767	2.013	0.989	8.518	6.822
C3	11.918	1.446	1.309	24.129	0.397	1.221
C4	4.306	18.767	2.013	0.989	8.518	6.822
C5	6.476	9.454	7.194	1.409	15.066	26.363
C6	5.407	3.486	21.875	12.656	0.615	6.220
C7	7.097	8.923	7.393	14.333	0.734	0.402
C8	7.097	8.923	7.393	14.333	0.734	0.402
C9	1.023	7.943	30.521	8.744	0.703	0.011
C10	11.246	4.765	4.031	2.176	1.023	6.290
C11	11.118	0.249	8.289	6.291	22.215	1.273
C12	11.246	4.765	4.031	2.176	1.023	6.290
C13	8.336	3.911	3.873	6.637	39.609	37.635

Table 10: Squared Cosines of the Variables

	F1	F2	F3	F4	F5	F6
C1	**0.673**	0.290	0.001	0.032	0.002	0.001
C2	0.278	**0.633**	0.040	0.006	0.025	0.017
C3	**0.770**	0.049	0.026	0.151	0.001	0.003
C4	0.278	**0.633**	0.040	0.006	0.025	0.017
C5	**0.418**	0.319	0.144	0.009	0.044	0.066
C6	0.349	0.118	**0.437**	0.079	0.002	0.016
C7	**0.458**	0.301	0.148	0.090	0.002	0.001
C8	**0.458**	0.301	0.148	0.090	0.002	0.001
C9	0.066	0.268	**0.609**	0.055	0.002	0.000
C10	**0.726**	0.161	0.080	0.014	0.003	0.016
C11	**0.718**	0.008	0.165	0.039	0.065	0.003
C12	**0.726**	0.161	0.080	0.014	0.003	0.016
C13	**0.538**	0.132	0.077	0.042	0.117	0.094

Note: *Values in bold correspond for each variable to the factor for which the squared cosine is the largest*